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Rafael de Castro Nobre

The Fibonacci Sequence: Relationship to the Human Cerebrum and Corpus Callosum

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The Fibonacci Sequence: Relationship to the Human Cerebrum and Corpus Callosum

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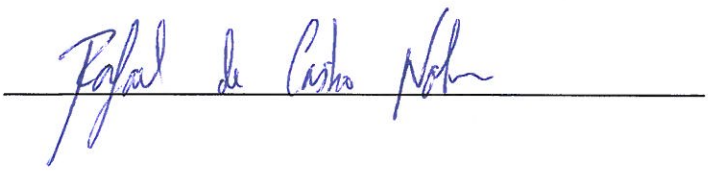

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Neurocirurgia

TÍTULO DISSERTAÇÃO/MONOGRAFIA (riscar o que não interessa)

The Fibonacci Sequence: Relationship to the Human Cerebrum and Corpus Callosum

ORIENTADOR

Dr. Paulo José Campos Linhares Vieira

COORIENTADOR (se aplicável)

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É AUTORIZADA A REPRODUÇÃO INTEGRAL DESTE TRABALHO APENAS PARA EFEITOS DE INVESTIGAÇÃO, MEDIANTE DECLARAÇÃO ESCRITA DO INTERESSADO, QUE A TAL SE COMPROMETE.	☐
É AUTORIZADA A REPRODUÇÃO PARCIAL DESTE TRABALHO (INDICAR, CASO TAL SEJA NECESSÁRIO, Nº MÁXIMO DE PÁGINAS, ILUSTRAÇÕES, GRÁFICOS, ETC.) APENAS PARA EFEITOS DE INVESTIGAÇÃO, MEDIANTE DECLARAÇÃO ESCRITA DO INTERESSADO, QUE A TAL SE COMPROMETE. – RESUMO E ABSTRACT	☒
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Faculdade de Medicina da Universidade do Porto, 15/03/2016

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Aos que vêem o belo onde os outros apenas vêem a forma.
Aos meus pais e à minha irmã.

The Fibonacci Sequence: Relationship to the Human Cerebrum and Corpus Callosum

Rafael Castro Nobre [1*], Paulo Linhares [1, 2]

Authors' affiliation:

[1] Medical Faculty of Porto University | [2] Department of Neurosurgery, Centro Hospitalar S. João, Porto, Portugal.

Emails:

[*] Rafael de Castro Nobre – rcastronobre@gmail.com | Paulo Linhares - paulojlinhares@yahoo.com;

[*]Author for correspondence:

Rafael Castro Nobre, Medical Faculty of Porto University, Alameda Prof. Hernâni Monteiro, 4200 - 319 Porto, Portugal Tel: + 351 225 512 100; Fax: + 351 225 025 766

E-mail: rcastronobre@gmail.com

Abstract:

Background:
Beauty represents a proportional harmony in geometrical relations applied to all standards proposed to society. The Golden Number's a proportion seen in this aesthetic harmony. Fibonacci Sequence's a mathematical sequence where each number's defined by the sum of the 2 preceding numbers. The ratio of this 2 successive numbers' taken to its infinite term, called Phi, whose value's 1,618.
The Golden Ratio (GR) can be applied in almost every distribution of structures in nature and in human body. Human organs like heart or skull follow this rule. Until now this proportion wasn't applied to the human brain.
The aim of his study's to determine if the normal human brain follows the GR, particularly if the cerebrum and corpus callosum anatomy respects the divine proportions, if the ratio of the measures is 1,618.
Method:
We analyzed 100 normal brain MRI, measured the longitudinal and transversal proportions of the cerebrum and the corpus callosum and calculated the ratio between then.
We calculated the mean and the standard ratio to both ratios, than we compared the actual mean to the hypothetical mean (1,618) and based on it we determine if the difference's statistically significant (p value). We also calculated the upper limit (UL) and lower limit (LL) (95% CI) and the maximum, minimum and median.
Results:
Cerebrum: Mean 1,621 (p-value=0,532), UL 1,632**,** LL 1,611.
Corpus callosum: Mean 1,651 (p-value<0,0001), UL 1,663**,** LL 1,638.
Conclusions:
The normal cerebrum respects the GR. Alterations in these measures can lead to early diagnosis of different pathologies.

Keywords:
Fibonacci Sequence; Golden Ratio; Cerebrum; Corpus Callosum; Spiral; Neuroanatomy

Introduction:

For those who contemplate beauty, feeling the stimulus that it causes in our senses is like to meet a world that confers real meaning on life. Artists, philosophers and scientists have tried in their works unravel the mystery and charm of beauty concepts.

Beauty represents a proportional harmony in numerical and geometrical relations applied to almost all standards proposed to society.

In the fifth century BC, the Greek sculptor Phidias repeatedly applied the Golden Ratio to his works and in his honor the Golden Number is represented by the Greek letter Φ (Phi). The Phi Number corresponds to 1,618. According to the Golden Proportion, the ideal ratio is 1 cm to 1,618 cm, which is the equilibrium between all things and the perfect symmetry. So the Phi number has been known as the Divine Proportion.

For many years people have been seeking the perfect beauty and the ideal proportion. The Greeks created the Golden Rectangle, a rectangle with defined ratios (the long side divided by the smaller side is always 1,618) and from that proportion everything was built. So, they built the Parthenon (starting by a proportion of the rectangle forming the central and lateral side); either, the depth divided by length or height follows the ideal ratio of 1,618. The Egyptians did the same with the pyramids - each stone was 1,618 times greater than the stone above.(1)

In 1200, Leonardo Fibonacci, a mathematician who studied the growth of rabbit populations, created what is probably the most famous mathematical sequence: the Fibonacci Sequence. From one pair of rabbits, Fibonacci observed that their number increased from breeding several generations and came to a sequence, where a number is the sum of the two preceding numbers:

1
1+1=2
1+2=3
2+3=5
3+5=8
5+8=13
8+13=21
13+21=34

The average rate of the growth series is 1,618...

When we analyze the natural world, it becomes clear that the distribution of most structures follows the golden ratio. The distribution of tree branches, petals, flowers and so on, obeys the golden rule. The leaves along a branch are arranged by this proportionality and they never stand exactly one below the other. In fact, each leaf is positioned 1,618 below and beside the other and because of this rainwater and sunlight will reach all sequentially.

The Vitruvian Man by Leonardo Da Vinci is used as aesthetic reference to the basic symmetry and proportions of the human body applied to the design of human beauty and harmonious relations between the parts that make up our body. Da Vinci applied these ideas to the human anatomy in his depiction of the perfect man, and the Vitruvian Man dimensions obey the golden ratio, which represents the expression of a man with the ideal proportions. In the Vitruvian Man, the human body is shown at the same time, inside two figures (a circle and a square), and the navel is the gravitational center of the human figure, which coincides with the center of two geometric figures. The total area of the circle is identical to the total area of the square and this pattern can be considered a mathematical algorithm to calculate the value of the irrational number Phi.(1)

By looking into the human body, we can conclude that there are also "divine rules". For example, in the lungs, the blood vessels follow the same procedure that branches or tree roots, which are divided in numbers reflecting the Fibonacci series.

At birth, the navel divides the body into equal parts, but after 13 years, the navel divides the body in the golden ratio: the bottom is 1,618 times higher.

The ratio between arm length and the measured from the elbow to the fingers is 1,618. About the fingers, if we divide the measure of the entire finger by the length from the proximal phalanx to the tip of the finger; or if we divide the measure from the proximal phalanx to the end, by the distance between the distal phalanx to the end, the result will be 1,618. The whole leg divided by measurement from knee size to the ground is 1,618. (3)

The skull height divided by the length of the jaw to the tip of the head is 1,618. (4) In the healthy heart, the ratio between the vertical and transverse dimensions is 1,618. In the ventricles, the mitral ring respects the divine proportions. (2)

The cerebrum and the corpus callosum are presented as having a spiraloid structure according to the mathematical standard of the Golden Ratio. However, if we approach the vertical and transverse measurements of the corpus callosum, we can infer if it will be or not be in the golden ratio.

Therefore, this study aims to determine whether the human brain - more specifically the anatomy of the cerebrum and corpus callosum - respects the divine proportions, that is, if the ratio of the measures of this structure gives the value Phi (1,618).

In view of the foregoing we infer about the understanding of and admiration for the order and beauty of the human body and the world we live.

Material and Methods:

We analyzed 100 normal brain MRI, 43 females and 57 males with ages between 18 and 80 years old.

We excluded any MRI with the existence of mass effect or brain tumors, compression effect, demyelinating disease - multiple sclerosis, progressive multifocal leukoencephalopathy -, and anatomical genetic abnormality, corpus callosum dysgenesis, or anencephaly.

On these imaging we measured the corpus callosum along two perpendicular lines (line "a" and line "b")– as we demonstrate in Figure 1. The first leaves the most anterior point of the knee of the corpus callosum to the most posterior point of the rostrum of the corpus callosum. Perpendicularly to this, we traced another line, tangent to the anterior commissure, which delimits the uppermost points and bottom of the corpus callosum.

We also measured the cerebrum – as shown in Figure 2 - through a longitudinal straight line from the most anterior point of the frontal lobe to the most posterior point of the occipital lobe (line "b"); and another transverse cross since the uppermost point of the frontal lobe to the lowest point in the brain, the temporal lobe (line "a").

Finally we calculated the ratio between the highest and the lowest straight to both brain structures.

Statistical analysis was performed with SPSS 22.0 software package.

We calculated the mean, we compared it to the hypothetical mean (Phi) and calculated the difference between these two values. We also calculated the standard deviation and the upper and the lower limit to a 95% CI and we checked if the mean was contained in the range of those values. Finally we noted the maximum, the minimum and the median to the both ratios of cerebrum and corpus callosum.

To the analysis, the variables that showed significance at $p<0,20$ were included. A p-value$<0,05$ was used as the criterion for a statistical significance. The results are expressed with a 95% confidence interval.

Results:

The results of measures and the quotient between the measures of the cerebrum and the corpus callosum are both provided in Table 1. The 95% confidence interval for the ratio of the cerebrum and the corpus callosum are presented in Table 2.

Phi (Fibonacci Number), which is 1,618, is contained in the 95% confidence interval only for the quotient of the cerebrum proportions.

The actual mean to cerebrum is 1,621 and the difference between that and the hypothetical mean (witch is Phi) is 0,003 and the two-tailed p-value equals 0,532 – as presented in Table 2. So by the criteria this difference is considered to be not statistically significant.

The minimum value to the ratio of cerebrum's measures is 1,433 and the maximum is 1,790 – as we can observe in Table 3, where we present the median of the values too.

The statistic analysis to the corpus callosum is presented in Tables 2 and 3. The mean of ratio is 1,651 and the difference between that and the Golden Number is 0,033, so the two-tailed p-value is less than 0,0001. Because of that this difference is considered to be extremely statistically significant.

To this aim we can conclude that the ratio of the corpus callosum measures did not contain Phi so this structure does not respect the Golden Ratio.

The results of the quotient between the measures of the cerebrum are presented on Graphic 1, the ratio of the corpus callosum measures are provided on Graphic 2, and the parallel of both ratio is presented on Graphic 3.

Discussion:

About the cerebrum and corpus callosum, despite having a spiraloid structure, nobody knows if it is a perfect spiral according to the Golden Ratio and the Fibonacci Sequence

Leonardo Fibonacci described the most famous mathematical sequence - the Fibonacci Sequence - in the 13th century. Starting with one pair of rabbits, Fibonacci observed that their number increased from breeding several generations and came to a sequence.[1] In Fibonacci Sequence each number is defined by the sum of the 2 preceding numbers (0, 1, 0+1=1, 1+1=2, 1+2=3, 2+3=5, 3+5=8, 5+8=13, 8+13=21, 13+21=34, 21+34=55, 34+55=89, and so forth).

The Golden Rule can be applied to almost every distribution of structures in nature, such as the distribution of tree branches or the localization of the leaves along a branch; in the human body the Fibonacci sequence can be applied to the blood vessels in the lungs, to the phalanges of the fingers [3], to hearth dimensions[4], or to the aesthetic standards of the face.[2]

The ratio of 2 successive numbers in Fibonacci's Sequence is taken to its infinite term, called Phi whose value is 1,618.

The Golden Square is a square where the ratio of longitudinal and transversal measures is 1,618 (Phi).[1]

In this study, it was verified that the ratio of the cerebrum longitudinal and transversal measures was approximated Phi, to a 95% Confidence Interval (p=0,05), with the lower limit 1,611 and the upper limit 1,632. The corpus callosum was equally measured and we concluded that the ratio wasn't nearly Phi, because the lower limit is 1,638 - which is more than 1,618 -, and the upper limit is 1,663.

As we can conclude from Graphic 3, the values of the ratio of the corpus callosum and the cerebrum fluctuate the same way despite some points of divergence.

However, in spite of the similar ratio variation, we note that the corpus callosum ratio values are slightly higher than those of the cerebrum in almost all of the measurements, which explains why, for the same confidence interval, the proportions of the cerebrum are in accordance with the Golden Ratio and corpus callosum proportions are not, although the difference of the quotients is in fact very small – the lower limit of corpus callosum ratio is only 1,68% bigger than the lower limit of the cerebrum ratio, and it is 1,2% bigger than Phi.

Therefore, we conclude that the corpus callosum does not have the Divine Proportions but it has ratios close to this standard.

Furthermore, we can conclude that the human cerebrum has the Golden Proportion, and about that we can establish a relation with the Golden Rectangle.

The Golden Rectangle is a figure whose the quotient between the longitudinal and transversal proportions is 1,618. From a Golden Rectangle we can construct a perfect spiral by the Fibonacci Sequence – the Golden Spiral.

If we divide a golden rectangle into a square and a rectangle, the new rectangle will also have the divine proportions. Repeating the process and dividing this new rectangle into a square and rectangle we will have a Golden Rectangle again. Now, if we do this procedure infinitely and unite the corners of the generated square, we get a Golden Spiral. [1]

Therefore, if we apply the previous procedure to the Golden Rectangle formed by the human cerebrum proportions, we can also build a Divine Spiral associated to the Cerebrum, such as we can see on Figure 3.

So, we can conclude that the human cerebrum is a Golden Spiral.

On the other hand, the corpus callosum - the other structure we measured in this study – doesn't have the divine proportions, and because of this, it is not possible to build, from the corpus callosum, a rectangle and consequently a spiral according to the values of the Fibonacci Sequence.

Thus, we conclude that the corpus callosum - despite this spiraloid structure - is not a perfect spiral by the Fibonacci Sequence.

Conclusion:

The normal cerebrum respects the Golden Ratio.

This study enables us to infer that brains whose cerebrum proportions are inconsistent with the Golden Rule can match unhealthy brains.

Thus, through the longitudinal and transverse measures and their ratio, it may be possible, in the future, to indicate early stages of different pathologies and this can lead to early diagnosis.

Conflict of Interest Statement:

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest (such as honoraria; educational grants; participation in speakers' bureaus; membership, employment, consultancies, stock ownership, or other equity interest; and expert testimony or patent-licensing arrangements), or non-financial interest (such as personal or professional relationships, affiliations, knowledge or beliefs) in the subject matter or materials discussed in this manuscript.

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Ethical approval:
All procedures performed in studies involving human
participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.
For this type of study formal consent is not required.

Informed consent:
Informed consent was obtained from all individual participants included in the study.

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Attachments:

Table 1										
				Corpus Callosum				Cerebrum		
	Age	Genre		Length	Height	Ratio		Length	Height	Ratio
1.	49	M		49,7	29,9	1,662		164,9	101,4	1,626
2.	49	M		51,1	30,3	1,686		163,3	102,2	1,598
3.	91	F		55,0	33,9	1,622		150,7	89,7	1,680
4.	91	F		63,9	39,3	1,626		155,5	100,2	1,552
5.	66	M		64,3	39,2	1,640		155,1	100,8	1,539
6.	80	M		49,4	30,2	1,636		159,2	98,2	1,621
7.	52	F		45,2	27,8	1,626		162,6	100,6	1,616
8.	41	F		44,4	26,7	1,663		149,2	92,8	1,608
9.	49	M		53,9	32,3	1,669		153,2	95,8	1,599
10.	49	M		43,9	27,7	1,585		148,4	89,4	1,660
11.	58	F		44,8	26,8	1,672		144,4	86,5	1,669
12.	35	M		49,0	28,7	1,707		160,0	97,5	1,641
13.	35	M		47,7	28,8	1,656		158,1	94,4	1,675
14.	57	F		46,0	28,0	1,643		150,4	96,0	1,567
15.	65	M		54,7	32,8	1,668		161,8	101,3	1,597
16.	43	F		58,5	36,0	1,625		165,2	102,2	1,616
17.	65	F		50,1	29,7	1,687		157,5	98,3	1,602
18.	32	F		50,3	31,0	1,623		159,9	98,0	1,632
19.	35	F		40,7	27,1	1,502		165,1	99,9	1,653
20.	48	F		46,2	27,6	1,674		147,0	92,5	1,589
21.	41	M		54,3	32,6	1,666		160,8	95,6	1,682
22.	22	F		45,7	27,9	1,638		153,5	85,8	1,789
23.	42	M		45,1	27,4	1,646		159,8	99,6	1,604
24.	82	M		45,8	28,4	1,613		153,2	90,8	1,687
25.	49	F		55,7	33,7	1,653		159,0	98,3	1,617
26.	63	M		51,8	30,4	1,704		160,2	101,6	1,577
27.	36	F		46,7	29,1	1,605		154,5	99,4	1,554
28.	68	M		48,8	30,3	1,611		152,3	94,5	1,612
29.	58	M		58,8	36,1	1,629		159,5	98,5	1,619
30.	37	F		51,9	30,3	1,713		161,1	99,8	1,614
31.	47	M		49,4	30,3	1,630		151,9	89,9	1,690
32.	53	F		43,2	26,7	1,618		153,1	97,8	1,565
33.	54	F		50,8	31,0	1,639		159,3	102,5	1,554
34.	26	F		50,7	31,2	1,625		157,2	94,2	1,669
35.	45	F		51,9	30,3	1,713		160,3	99,9	1,605
36.	38	F		52,2	32,8	1,591		157,0	93,4	1,681
37.	55	M		46,3	27,4	1,690		155,4	97,0	1,602
38.	68	M		45,7	27,5	1,662		149,2	92,8	1,608

39.	53	M		58,8	36,1	1,629		150,7	89,7	1,680
40.	35	F		47,9	29,8	1,607		160,0	97,9	1,634
41.	68	M		51,9	30,3	1,713		155,5	100,2	1,552
42.	47	F		51,7	30,8	1,679		159,5	99,0	1,611
43.	68	F		50,4	30,5	1,652		152,7	95,4	1,601
44.	66	F		55,8	31,9	1,749		151,9	90,1	1,686
45.	64	M		43,2	26,7	1,618		155,1	100,8	1,539
46.	40	M		51,7	30,9	1,673		170,0	103,2	1,647
47.	57	F		55,2	34,1	1,619		157,8	98,1	1,609
48.	58	M		48,8	30,3	1,611		163,3	102,2	1,598
49.	63	F		50,6	29,8	1,698		153,9	91,7	1,678
50.	70	F		53,4	31,8	1,679		168,0	103,9	1,617
51.	61	F		55,2	33,9	1,628		159,3	99,1	1,607
52.	54	F		49,2	30,2	1,629		158,0	102,4	1,543
53.	50	F		45,6	28,1	1,623		152,1	94,1	1,616
54.	54	M		55,7	33,7	1,653		160,0	100,4	1,594
55.	64	M		45,8	28,4	1,613		152,5	96,3	1,584
56.	52	F		50,4	30,6	1,647		154,7	95,5	1,620
57.	48	F		50,5	32,0	1,578		164,4	101,9	1,613
58.	51	M		53,4	31,8	1,679		168,1	104,0	1,616
59.	41	F		47,8	29,5	1,620		158,9	97,6	1,628
60.	67	M		54,8	32,7	1,676		152,9	94,2	1,623
61.	56	F		47,2	28,0	1,686		148,2	89,0	1,665
62.	77	M		54,2	32,2	1,683		157,0	100,9	1,556
63.	59	F		55,9	32,1	1,741		156,1	91,0	1,715
64.	32	F		39,1	24,7	1,583		156,6	93,6	1,673
65.	43	F		49,9	29,8	1,674		147,0	91,1	1,614
66.	45	F		50,0	29,4	1,701		157,6	98,5	1,600
67.	41	M		50,5	26,3	1,920		162,4	102,5	1,584
68.	52	F		46,5	28,3	1,643		153,8	95,9	1,604
69.	25	F		47,6	28,9	1,647		153,7	92,9	1,654
70.	80	M		60,1	35,9	1,674		161,1	94,8	1,699
71.	29	F		52,1	30,7	1,697		166,0	98,9	1,678
72.	54	F		48,5	30,1	1,611		145,6	94,4	1,542
73.	28	M		56,1	34,8	1,612		170,0	103,1	1,649
74.	27	M		46,6	27,5	1,695		154,8	95,6	1,619
75.	55	F		60,5	38,6	1,567		155,0	96,5	1,606
76.	26	M		40,8	28,6	1,427		153,4	99,2	1,546
77.	80	F		83,6	50,8	1,646		181,8	107,5	1,691
78.	49	F		62,2	34,6	1,798		154,5	107,8	1,433
79.	40	M		49,7	32,1	1,548		169,8	108,4	1,566
80.	45	F		46,1	27,5	1,676		147,0	82,1	1,790
81.	72	F		50,4	30,3	1,663		153,2	90,2	1,698
82.	75	F		56,2	32,0	1,756		159,2	101,2	1,573

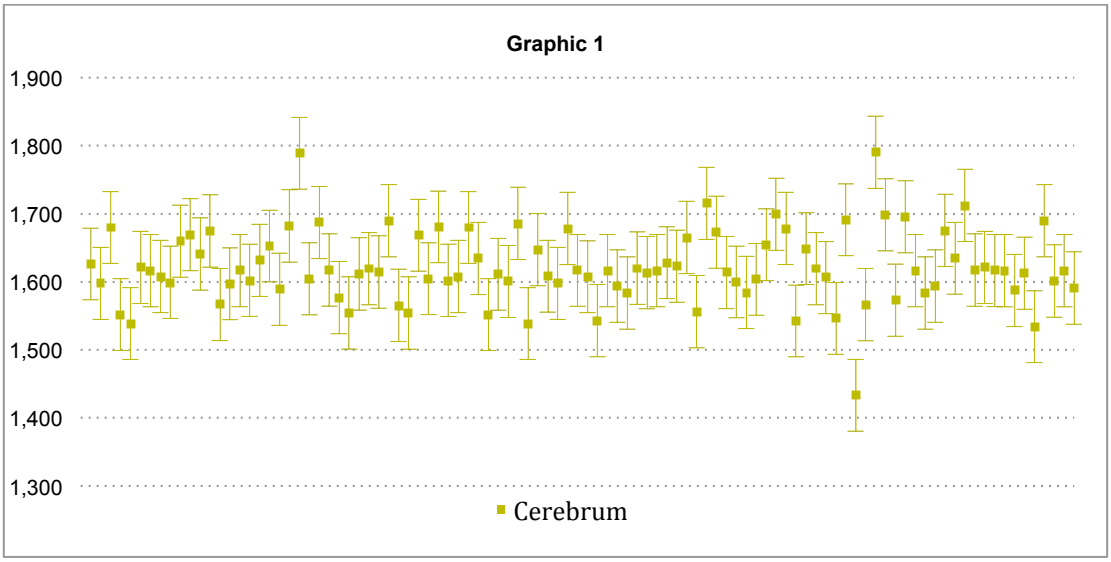
83.	39	M		50,5	30,2	1,672		152,1	89,7	1,696
84.	72	F		47,6	29,0	1,641		152,1	94,1	1,616
85.	41	F		51,8	26,5	1,955		152,5	96,3	1,584
86.	40	M		53,8	32,7	1,645		160,0	100,4	1,594
87.	57	F		45,9	27,8	1,651		158,5	94,6	1,675
88.	29	F		54,3	33,4	1,626		158,9	97,2	1,635
89.	21	F		49,9	30,0	1,663		158,9	92,8	1,712
90.	45	F		46,2	28,3	1,633		159,3	98,5	1,617
91.	42	M		49,4	30,3	1,630		159,2	98,2	1,621
92.	57	F		45,2	27,8	1,626		151,8	93,9	1,617
93.	18	M		46,5	28,4	1,637		162,6	100,6	1,616
94.	58	F		49,4	30,3	1,630		157,3	99,1	1,587
95.	55	M		46,5	28,4	1,637		153,7	95,3	1,613
96.	37	M		51,1	34,5	1,481		162,9	106,2	1,534
97.	64	M		45,7	27,5	1,662		151,9	89,9	1,690
98.	30	M		45,6	28,1	1,623		162,2	101,3	1,601
99.	43	F		57,7	36,0	1,603		161,3	99,8	1,616
100.	63	M		57,5	35,9	1,602		159,4	100,2	1,591

Table 2

	Mean	p-value	Standard Ratio	Confidence Interval 95%	Upper Limit	Lower Limit
Corpus Callosum	1,651	< 0,0001	0,066	0,013	1,663	1,638
Cerebrum	1,621	**0,532**	0,053	0,010	**1,632**	**1,611**

Table 3

	Median	Maximum	Minimum
Corpus Callosum	1,644	1,955	1,427
Cerebrum	1,616	1,790	1,433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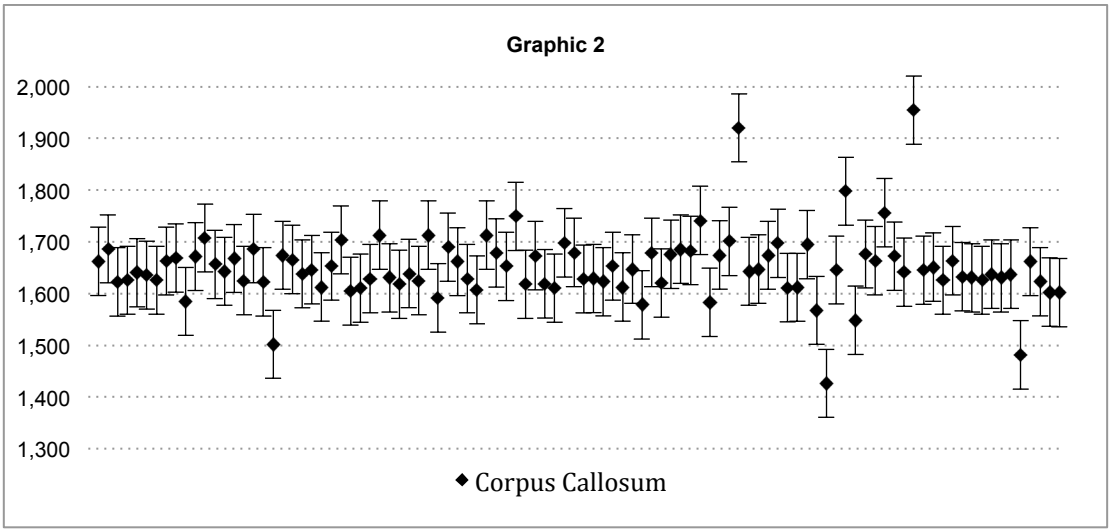
1,800
1,700
1,600
1,500
1,400
1,300
Cerebrum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1,900
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1,700
1,600
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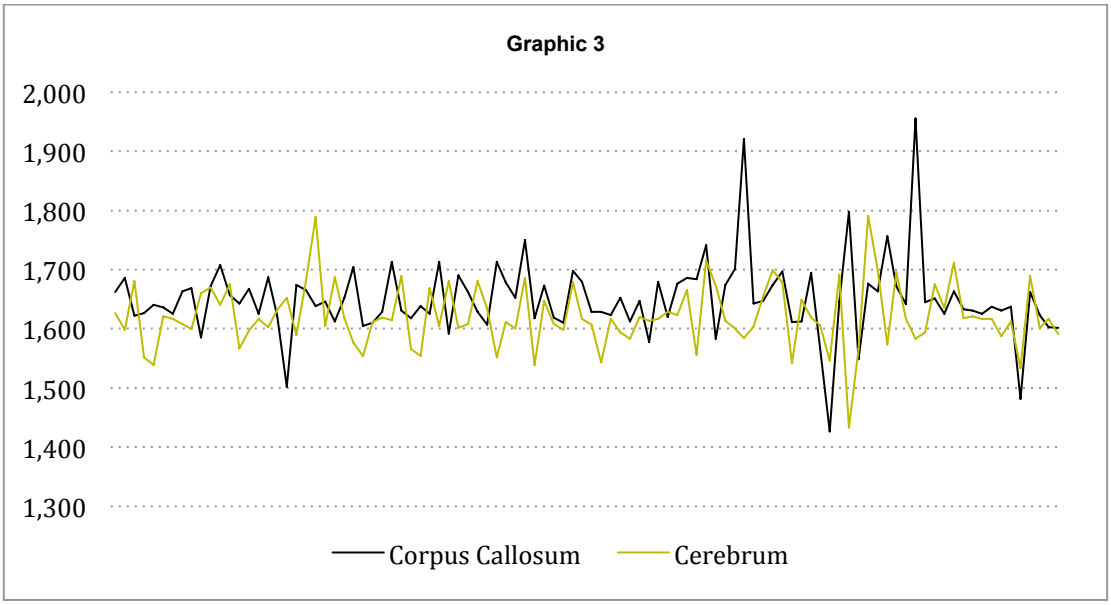
1,300
Corpus Callosum


Graphic 3
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1,800
1,700
1,600
1,500
1,400
1,300
Corpus Callosum
Cerebrum

Figure 1

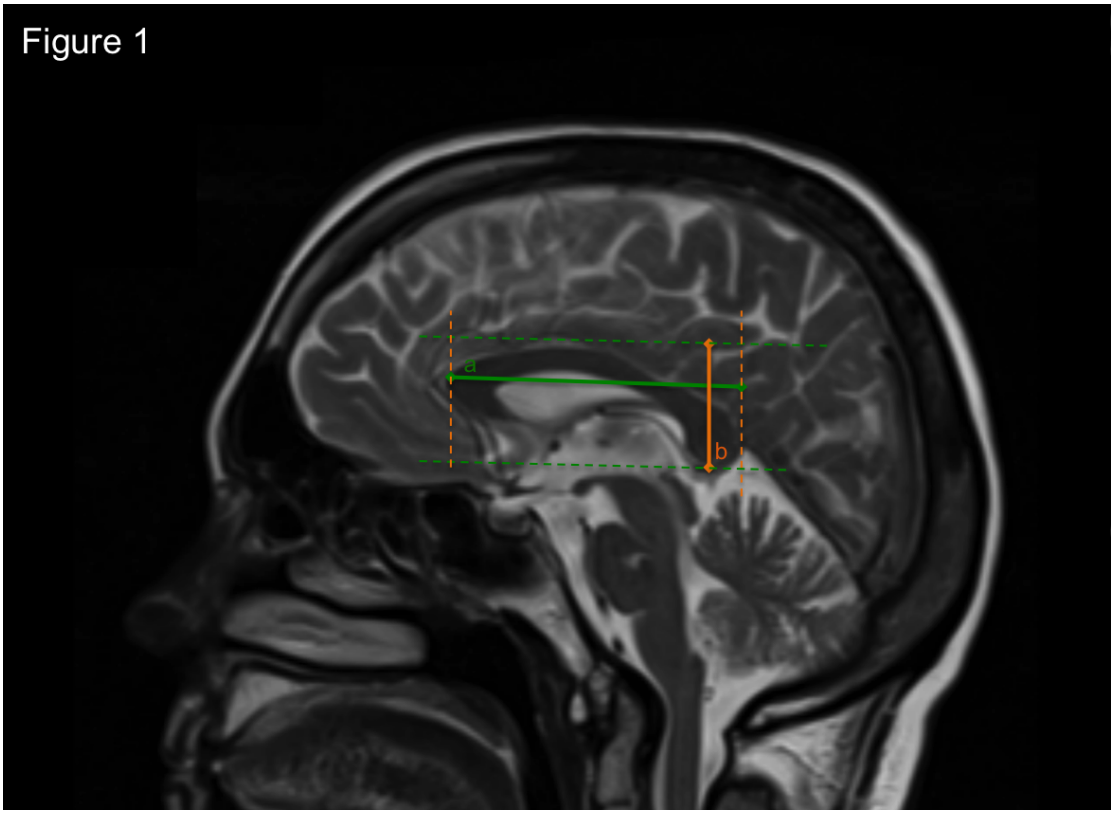
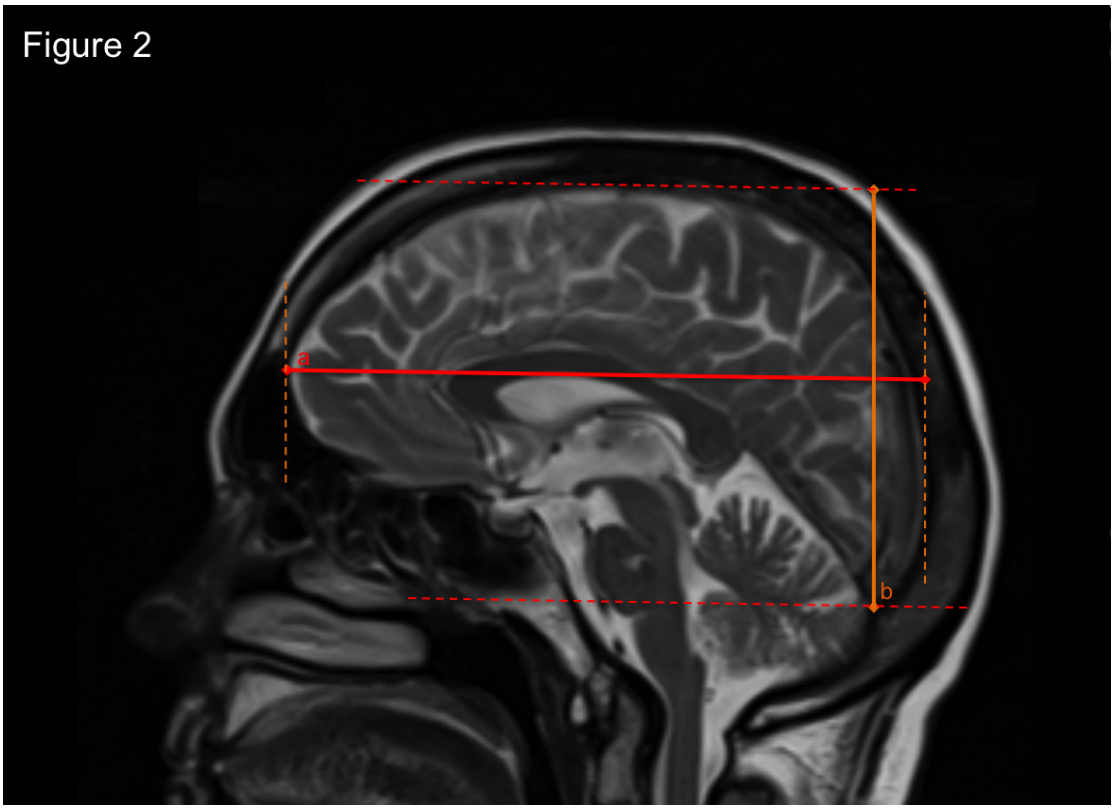


Figure 2



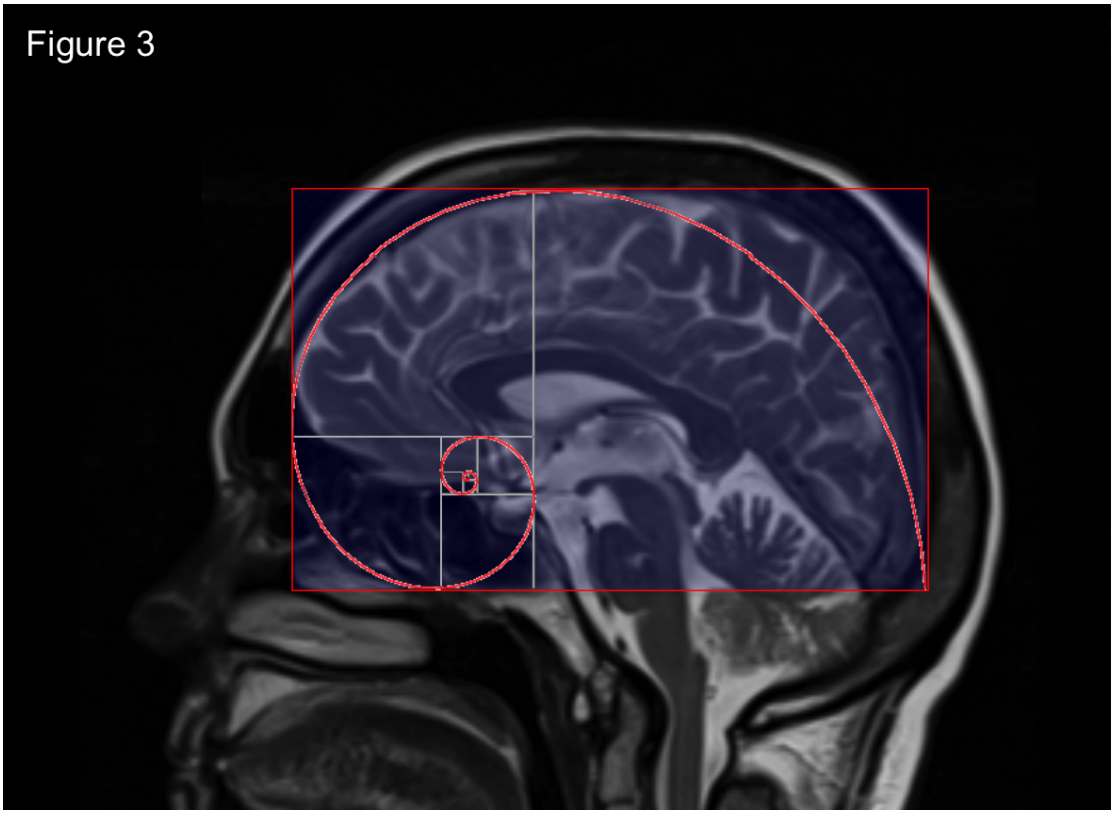


Figure 3

Agradecimentos

Ao Dr. Paulo Linhares, por ter aceite o meu desafio e me ter ajudado incondicionalmente a realizar este trabalho singular, por toda a orientação e disponibilidade que sempre manifestou.

Aos meus pais, por sempre me terem educado a ver o mundo pelo lado da Arte, por me terem ensinado a ver a beleza em todas as formas, por me disciplinarem que "A Medicina é, para além de Ciência, Arte".

À minha irmã por todo o apoio e ajuda que me deu na realização deste trabalho e por ter contribuído em todos os pormenores que fizeram a diferença.

Aos meus amigos, por todos os momentos que vivi nesta faculdade, por tudo o que me ensinaram, por sempre me apoiarem e protegerem e, acima de tudo por me fazerem crescer enquanto futuro médico e pessoa.

Anexos

Unidade de Investigação
Nada a opor.

23 de Fevereiro de 2016

A Coordenadora da Unidade de Investigação

(Prof.ª Doutora Ana Azevedo)

DC 1/3/2016
Aprovado pela CA.
DIRECÇÃO CLÍNICA
1/3/2016 DC41

CES 20-16

Exmo. Senhor
Presidente do Conselho de Administração do
Centro Hospitalar de S. João – EPE

AUTORIZADO
CONSELHO DE ADMINISTRAÇÃO REUNIÃO DE 04 MAR 2016
Presidente do Conselho de Administração
(Dr. António Oliveira e Silva)
Diretor Clínico (Prof. Dr. José Artur Paiva) | Enfermeira Diretora (Enf.ª Filomena Cardoso) | Vogal Executivo (Dr. Luís Pinto Guimarães) | Vogal Executivo (Dr. Renato G. Matos)

Assunto: Pedido de autorização para realização de estudo/projecto de investigação

Nome do Investigador Principal: Rafael de Castro Nobre

Título do projecto de investigação: The Fibonacci Sequence: Relationship to the Human Cerebrum and Corpus Callosum

Pretendendo realizar no(s) Serviço(s) de Neurocirurgia do Centro Hospitalar de S. João – EPE o estudo/projecto de investigação em epígrafe, solicito a V. Exa., na qualidade de Investigador/Promotor, autorização para a sua efectivação.
Para o efeito, anexa toda a documentação referida no dossier da Comissão de Ética do Centro Hospitalar de S. João respeitante a estudos/projectos de investigação, à qual endereçou pedido de apreciação e parecer.

Com os melhores cumprimentos.

Porto, 17 / Dezembro / 2015

O INVESTIGADOR/PROMOTOR

Rafael de Castro Nobre

SÃO JOÃO
HOSPITAL

Comissão de Ética para a Saúde do HSJ

Parecer

Projeto intitulado "The Fibonacci Sequence: relationship to the Human Cerebrum and Corpus Callosum".

Estudo que pretende vir a ser desenvolvido no Serviço de Neurocirurgia do CHSJ pelo estudante do MI em Medicina pela FMUP Rafael de Castro Nobre, sob orientação do Dr. Paulo Linhares, que servirá de elo de ligação.

Do ponto de vista científico trata-se de um estudo que pretende avaliar, a anatomia do corpo caloso em exames de Ressonância Magnética Cerebral (n previsto de 100), no sentido de averiguar se o corpo caloso respeita as proporções previstas, de acordo com a proporção áurea (valor de Phi 1,618). Dos resultados poder-se-à inferir a relação entre alterações encontradas e eventuais patologias associadas.

Não estão previstos riscos ou benefícios diretos para participantes e não serão realizados questionários.

Está previsto o acesso aos dados clínicos pelo investigador, através do elo de ligação.

Face à natureza do estudo, a obtenção de consentimento informado é dispensável.

O investigador dispõe da competência científica para realização do estudo que está autorizado pelo diretor do Serviço de Neurocirurgia.

O estudo não prevê a realização de exames complementares e não é financiado.

Em face da análise do protocolo proponho a sua aprovação pela CES do CHSJ.

Porto, 27 de janeiro de 2016

O relator

Prof. Manuel Pestana

7. SEGURO

a. *Este estudo/projecto de investigação prevê intervenção clínica que implique a existência de um seguro para os participantes?*

SIM ☐ (Se sim, junte, por favor, cópia da Apólice de Seguro respectiva)
NÃO ☒
NÃO APLICÁVEL ☐

8. TERMO DE RESPONSABILIDADE

Eu, Rafael de Castro Nobre , abaixo-assinado, na qualidade de Investigador Principal, declaro por minha honra que as informações prestadas neste questionário são verdadeiras. Mais declaro que, durante o estudo, serão respeitadas as recomendações constantes da Declaração de Helsínquia (com as emendas de Tóquio 1975, Veneza 1983, Hong-Kong 1989, Somerset West 1996 e Edimburgo 2000) e da Organização Mundial da Saúde, no que se refere à experimentação que envolve seres humanos. Aceito, também, a recomendação da CES de que o recrutamento para este estudo se fará junto de doentes que não tenham participado em outro estudo no decurso do actual internamento ou da mesma consulta.

Porto, 17 / Dezembro / 2015

Rafael de Castro Nobre

O Investigador Principal

PARECER DA COMISSÃO DE ÉTICA PARA A SAÚDE DO CENTRO HOSPITALAR DE S. JOÃO/FACULDADE DE MEDICINA DA UNIVERSIDADE DO PORTO

emitido na reunião plenária da CES de 29 / Janeiro / 2016

A Comissão de Ética para a Saúde APROVA por unanimidade o parecer do Relator, pelo que nada tem a opor à realização deste projecto de investigação.

Prof. Doutor Filipe Almeida
Presidente da Comissão de Ética para a Saúde

Instructions of Authors

Acta Neurochirurgica

The journal "Acta Neurochirurgica" publishes papers dealing with clinical neurosurgery - diagnosis and diagnostic techniques, operative surgery and results, postoperative treatment - or with research work in neuroscience where underlying questions or results are of neurosurgical interest. As official organ of the European Association of Neurosurgical Societies the journal publishes all announcements of the E.A.N.S. and reports on the activities of its member societies.

In addition to the regular journal, "Acta Neurochirurgica" publishes 3-4 supplement volumes per year. These comprise proceedings of international meetings or other material of general neurosurgical interest.

Related subjects » Neurology - Orthopedics - Radiology - Surgery

Subdivision of the paper

Please state clearly the format of your paper, i.e. Clinical Investigation, Case Report, Experimental Research, Letter to the Editor, Review Article, Technical Note.

Reports of Clinical, Experimental Research, Review Articles or Technical Notes.

For an original research paper the customary format consists of: abstract, introduction, methods and materials, results, discussion, references.

• The summary should be a short survey of the paper, structured using 4 headings: Background/ Method/ Results/ Conclusions. The abstract can run to a maximum of one full type-written page (300 words). Four to six keywords should be provided.

• The introduction should summarise the underlying purpose of the paper.

• Methods and materials must give short but precise descriptions, for instance of the kind of experiments and how they were done, the characteristics of patients or other humans participating as subjects, the nature of observations made and the specific approach to statistical considerations. This section should enable the reader to analyse, to repeat or to continue the work presented.

• Results must contain sufficient information to enable appreciation and assessment of the original findings, e.g. absolute numbers in subgroups should be reported, preferably in tabular format, rather than only as a percentage. Where a normal distribution is assumed as a basis for summarising data (e.g. as a mean), this should be justified and measures should be specified. Statistical tests should be presented in sufficient detail to convey the full result, not only as a “p” value.

• In discussion a systematic, structured approach is advised. A statement of the principal findings demonstrated by the work should be followed by a “self-critique”, focussing on the strengths and weaknesses of the study and how these may influence the validity and robustness of the findings. The relation of the work to other, relevant previous work, especially any differences, should be reviewed and analysed concisely. Finally, the implications of the findings of the study for advancing knowledge and understanding, for neurosurgical practice and for further work should be presented.

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Case reports should be limited to 6 pages of typescript (1500 words), including tables and illustrations. An abstract in a single paragraph, maximum 100 words, should be included. The presentation should both adequately characterise the features of the subject(s) reported and make clear what generalisable deductions can be drawn.

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This new section in the journal is for showing how surgical procedures are carried out.

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The word.doc file of your submission should be submitted as follows: Page 1: Title Page The title page should include:

Title of Paper Names(s) of all authors Affiliation Details of corresponding author-Full name, Affiliation, Full postal address, E-Mail/Fax details Presentation at a conference Clinical Trial Registration number if required Number the page-Title page will be page#1

Page 2: Abstract

A structured abstract is required between 150-250 words to be divided into the following headings:

Background Methods Results Conclusions

Keywords Please provide 4 to 6 keywords which can be used for indexing purposes

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Use a normal, plain font (e.g., 10-point Times Roman) for text. Use italics for emphasis. Use the automatic page numbering function to number the pages. Do not use field functions.

Use tab stops or other commands for indents, not the space bar. Use the table function, not spreadsheets, to make tables. Use the equation editor or MathType for equations.

Save your file in docx format (Word 2007 or higher) or doc format (older Word versions).

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Please use no more than three levels of displayed headings.

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Abbreviations should be defined at first mention and used consistently thereafter.

Footnotes

Footnotes can be used to give additional information, which may include the citation of a reference included in the reference list. They should not consist solely of a reference citation, and they should never include the bibliographic details of a reference. They should also not contain any figures or tables.

Footnotes to the text are numbered consecutively; those to tables should be indicated by superscript lower-case letters (or asterisks for significance values and other statistical data). Footnotes to the title or the authors of the article are not given reference symbols.

Always use footnotes instead of endnotes.

Acknowledgments

Acknowledgments of people, grants, funds, etc. should be placed in a separate section on the title page. The names of funding organizations should be written in full.

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The list of references should only include works that are cited in the text and have been previously published or accepted for publication.

Personal communications should only be mentioned in the text.

In the text, references should be noted in square brackets eg: [1] and listed in alphabetical order in the reference list.

Papers which have been accepted for publication but not yet published should be included in the list of references with the name of the journal and the Digital Object Identifier (DOI) code of the cited literature. The author is responsible for the accuracy of the references.

Following some examples for the style of references: Journal articles

(1)Franzini A, Messina G, Leone M, Broggi G (2009) Occipital nerve stimulation (ONS). Surgical technique and prevention of late electrode migration. Acta Neurochir 151:861-865

(2)Pinsker MO, Volkmann J, Falk D, Herzog F, Steigerwald F, Deuschl G, Mehdorn HM (2009) Deep brain stimulation of the internal globus pallidus in dystonia:target localisation under general anaesthesia. Acta Neurochir 151:751-758

Helmy A, Timofeev I, Palmer C, Gore A, Menon DK, Hutchinson PJ (2010) Hierarchial log linear analysis of admission blood parameters and clinical outcome following traumatic brain injury Acta Neurochir DOI: 10.1007/S00701-009-0584-y

Books

Frontera J (2009) Decision making in neurocritical care Thieme, Stuttgart Book Chapter

Always use the standard abbreviation of a journal's name according to the ISSN List of Title Word Abbreviations.

ISSN List of the Title Word Abbreviations

If you are unsure, please use the full journal title.

For authors using EndNote, Springer provides an output style that supports the formatting of in- text citations and reference list.

Endnote style (zip, 2 kB)

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All tables are to be numbered using Arabic numerals. Tables should always be cited in text in consecutive numerical order.

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Identify any previously published material by giving the original source in the form of a reference at the end of the table caption.

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The corresponding author will include a summary statement in the text of the manuscript in a separate section before the reference list, that reflects what is recorded in the potential conflict of interest disclosure form(s).

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See below examples of disclosures: **Funding:** This study was funded by X (grant number X).

Conflict of Interest: Author A has received research grants from Company A. Author B has received a speaker honorarium from Company X and owns stock in Company Y. Author C is a member of committee Z.

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